Nebraska Public Power District

Always there when you need us

Joe L. Citta, Jr.
Corporate Environmental Mgr.
PH: 402-563-5355

April 29, 2011

Ms. Shelley Schneider
Air Administrator, Air Quality Division
Nebraska Department of Environmental Quality
Suite 400, The Atrium
1200 N Street
Lincoln, NE 68509-8922

Subject: Nebraska Public Power District, Gerald Gentleman Station, Units 1 & 2, Sutherland, NE Supplemental BART Assessment – Dry Sorbent Injection (DSI) at 0.15 lb SO_2/MMBtu

Dear Ms. Schneider:

The enclosed April 28, 2011, Assessment is in regards to our telephone conversation on April 21, 2011, and responds to your request to analyze DSI operating costs for Gerald Gentleman Station (GGS) using the 0.749 lb SO_2/MMBtu baseline number and reducing emissions to the BART presumptive limit of 0.15 lb SO_2/MMBtu.

This Assessment represents a hypothetical mathematical exercise, performed by our consultants HDR and Sargent & Lundy, as explained in the attached documents.

When reviewing the Assessment please note the cost data are subject to the stated critical assumptions, and expert opinions of HDR and Sargent & Lundy regarding the uncertainty of DSI achieving this level of performance at GGS.

Given the uncertainty of DSI performance at GGS it remains NPPD's position that DSI is not "technically feasible" as the term is defined in the Regional Haze rule.

Should you have any questions regarding this information, please contact me.

Sincerely,

Joe L. Citta, Jr.
Corporate Environmental Manager

Enc.

cc: Mike Linder, NDEQ w/enc.
Jay Ringenberg, NDEQ w/enc.
Brad Reid, NDEQ w/enc.

HDR ONE COMPANY | *Many Solutions* ℠

Nebraska Public Power District, Gerald Gentleman Station, Units 1 & 2, Sutherland, NE

Supplemental BART Assessment – Dry Sorbent Injection (DSI) at 0.15 lb SO_2/MMBtu

Prepared April 28, 2011

INTRODUCTION

As requested in April 2011 by the Nebraska Department of Environmental Quality, and on behalf of Nebraska Public Power District, HDR Engineering has prepared an additional analysis scenario with respect to the Regional Haze Best Available Retrofit Technology (BART) program. This scenario contemplates the use of dry sorbent injection (DSI) to reduce emissions at Gerald Gentleman Station Units 1 & 2 to 0.15 lb SO_2/MMBtu of heat input. This is considered here as a hypothetical or mathematical exercise, given there are no data to indicate that such a level can be attained at the facility with DSI technology.

The Steps 1 through 5 of the prior BART Analysis submission for DSI with a control level of 0.36 lb SO_2/MMBtu are largely the same as for the current scenario of 0.15 lb SO_2/MMBtu controlled level, so those steps are not repeated here. Rather, this abbreviated analysis provides a tabular summary of the results for this hypothetical scenario, along with additional discussion of the cost analysis and modeling results.

While attaining the 0.36 lb SO_2/MMBtu control level with DSI has a great deal of uncertainty, attaining a 0.15 lb SO_2/MMBtu control level has a far greater uncertainty. However, as requested by NPPD, HDR has conducted dispersion modeling of the more aggressive control case using the same CALPUFF model and meteorological databases as used in the prior DSI and other emissions control analyses for BART purposes in Nebraska.

Table 1 presents estimated DSI technology implementation costs, and Table 2 shows modeled cost/benefit modeling results for the DSI technology assumed to be meeting a control level of 0.15 lb SO_2/MMBtu. The DSI implementation costs for annual initial capital expenditure and annual operation and maintenance (O&M) in Table 1 were developed by Sargent & Lundy, with more detail shown in the April 28, 2011 exhibits attached to this document.

Table 2 provides the CALPUFF modeling results for the hypothetical DSI scenario in comparison to the baseline case. At essentially $100,000,000 per year per deciview, the annual average DSI cost/benefit value is approximately an order of magnitude greater than calculated in the many BART analyses done for other sources across the US (refer to Table 14 of the original

2008 BART Analysis for GGS). Also, this estimate is considered purely hypothetical, because there is no evidence this control level can be met with DSI technology.

Table 1. Annualized Costs for DSI @ 0.15 lbSO_2/MMBtu

Cost or Cost Effectiveness Element	DSI @ 0.015 lb SO2/MMBtu
Total Capital Cost	$208,330,000
Annualized Capital Cost	$17,500,000
Annual O&M Cost	$64,458,000
Total Annualized Cost	$81,958,000
Annual Tons SO_2 Removed	39,815
Cost Per Ton Removed	$2,058

Table 2. CALPUFF Model Results and Annual Average Incremental Cost Effectiveness for DSI at Presumptive BART Limit of 0.015 lb SO2/MMBtu

Control Scenario	Modeled Parameter	CALPUFF Results by Year of Meteorology[1]		
		2001	2002	2003
Baseline @ 0.749 lb/MMBtu	98th Percentile Impact (dV)	2.845	2.828	3.121
	Number of Days > 0.5 dV	54	55	60
DSI @ 0.15 lb/MMBtu	98th Percentile Impact (dV)	1.755	2.147	2.310
	Incremental Visibility Improvement (ΔdV)[2]	1.09	0.681	0.811
	Number of Days > 0.5 dV	35	37	39
	Incremental Impairment Improvement Cost ($/yr/$\Delta$dV)[3]	$75,190,826	$120,349,486	$101,057,953

[1]Maximum modeled Class I impacts for all years occurred at Badlands Natl. Park.

[2]Compared to baseline scenario.

[3]Total annualized cost & incremental visibility impairment improvement compared to baseline. Average over the three years of meteorology is $ 98,866,088.

RESULTS DISCUSSION & CONCLUSIONS

As discussed above and in the attached information from Sargent & Lundy, effective control of SO2 from units as large as like GGS 1 and 2 has not been demonstrated for DSI technology. Based the analysis presented, even if DSI could be employed to effectively reduce SO2 emissions at GGS, it would put NPPD's Nebraska citizens at substantial risk of much higher electric rates if the critical sorbent material (Trona) increases in price as demand increases. The sorbent costs for GGS could also rise dramatically if the sulfur level in the available coal increases, which could drive up the needed sorbent injection rates toward the levels presented in the earlier DSI analysis. There is also increasing risk that coal selection options will diminish because Powder River Basin coal suppliers are now shipping coal in ever-greater quantities to the West Coast, for export to Asia. The upward cost risk with DSI implementation is very substantial because the total DSI annualized cost is highly dependent on the O&M component, primarily due to sorbent consumption.

Finally, the cost/benefit of DSI implementation, even as analyzed here for an extremely optimistic control scenario, is still approximately an order of magnitude larger than the typical cost/benefit ratios shown for many other BART-subject sources across the nation (see Table 14 of the full BART Analysis document prepared for GGS).

In conclusion, the following points argue against DSI being selected as BART for GGS 1 & 2.

- Risk of greatly increasing sorbent costs with time as demand for Trona may increase.
- Risk of greatly increasing sorbent costs if coal sulfur for available PRB coals rises, especially given rapidly increasing export of PRB coal to Asia.
- Very high cost/benefit ($/yr/ΔdV) ratios compared to other facility BART technology applications.
- Extremely high uncertainty for a technology that has not been demonstrated in practice to meet the very optimistic control level of 0.15 lb SO_2/MMBtu analyzed here.

Sargent & Lundy LLC

William DePriest
Senior Vice President
312-269-6678
312-269-2499 (fax)
william.depriest@sargentlundy.com

April 28, 2011
Project No. 12681-003
Letter No. NPPD-SL-0286

Dry Sorbent Injection Cost Analysis for
Gerald Gentleman Station

Mr. Joseph L. Citta, Jr.
Corporate Environmental Manager
Nebraska Public Power District
1414 15th Street, P. O. Box 499
Columbus, NE 68601

Dear Joe:

In March 2011, Sargent & Lundy prepared a letter that responded to the Nebraska Department of Environmental Quality's (NDEQ) request to NPPD, to perform a side-by-side comparison of dry sorbent injection (DSI) to the wet and dry FGD technologies that were evaluated in the original 2008 Best Available Retrofit Technology (BART) Analysis. In the original 2008 BART Analysis, the FGD technologies were evaluated as being able to reduce SO_2 emissions to less than 0.15 lb SO_2/MMBtu for coals having as much as 2.27 lb SO_2/MMBtu. The operating and maintenance costs were evaluated based on a representative fuel that Gerald Gentlemen Station (GGS) expected to fire in the future with the installation of FGD, which was approximately 1.72 lb SO_2/MMBtu. Therefore, in order to perform a true side-by-side comparison, the DSI technology was evaluated at this inlet sulfur content.

In April 2011, the NDEQ requested of NPPD that DSI be evaluated based on an inlet sulfur content of 0.749 lb SO_2/MMBtu which is different than the inlet sulfur content used in the previous letter submitted in March 2011. This inlet sulfur content represents the maximum actual 24-hour baseline SO_2 emission over the 3-year period (2001-2003) that was used in the original 2008 BART Analysis for modeling GGS's deciview impact. The evaluation at this sulfur content would not represent a true side-by-side comparison to the FGD technologies that were evaluated in the original 2008 BART Analysis. However, in order to be responsive to the NDEQ request, S&L evaluated the operating and maintenance cost of DSI to reduce emissions to 0.15 lb SO_2/MMBtu based on a 0.749 lb SO_2/MMBtu inlet sulfur content. The capital costs of the DSI system remain unchanged from the previous letter. It should be noted that this evaluation to a 0.15 lb SO_2/MMBtu emission rate is strictly a mathematical exercise since it has not been proven that the DSI technology can achieve and maintain a reduction to 0.15 lb SO_2/MMBtu at GGS. The only way to determine whether this SO_2 emission rate could be achieved and maintained specifically for GGS would be to conduct extensive modeling and field testing at the site. Since this evaluation now stands on its own and is not meant to be a comparison to the original 2008 BART Analysis, S&L adjusted the SO_2 allowance price to current market conditions. In addition, this hypothetical scenario would remove all fuel flexibility and would limit GGS to firing fuel at or below 0.749 lb SO_2/MMBtu. Limiting GGS to fire this very low sulfur fuel could also result in the cost of fuel increasing at a higher rate of escalation in the future as proposed regulations (i.e. Utility MACT and Transport Rule) become law. Fuel costs were not included as part of this evaluation. In addition to fuel cost escalation, the cost of reagent could also increase at a higher rate of escalation than what was used as part of this evaluation since the escalation rate used was based on a mixture of various commodities. S&L expects that the escalation rate with respect to this specific commodity (i.e. dry sorbent) would increase at a higher rate due to the limited number of suppliers that provide reagent for use in the DSI system.

As stated in my previous letter (March 11, 2011), it remains S&L's judgment that the DSI technology has not been proven on any power plant the size of the GGS units and, therefore, should not be considered "technically feasible" as the term is defined in the Regional Haze rule. Even so, as requested by the NDEQ, S&L calculated the operating and maintenance costs for this hypothetical scenario and the results are contained in the attached exhibits.

Yours very truly,

William DePriest
Senior Vice President and
Director, Environmental Services

WD/jvk
Attachment
Copies:
J. M. Meacham
P. Hoornaert
D. G. Sloat

Question 1

Nebraska Public Power District
Gerald Gentleman Units 1&2

EXHIBIT 1
Dry Sorbent Injection Capital Cost

Project No. 12681-003
April 28, 2011

	GGS Unit 1	GGS Unit 2
Construction Direct		
Rail Unloading, Tracks and Switches	$ 1,995,000	$ 1,995,000
New Waste Silos	$ 4,676,000	$ 4,676,000
DSI System	$ 35,960,000	$ 35,960,000
Other Construction		
Engineering and Construction Management (5%)	$ 2,132,000	$ 2,132,000
Per Diem, Premium (5%)	$ 2,132,000	$ 2,132,000
Profit (10%)	$ 4,690,000	$ 4,690,000
EPC Fee (20%)	$ 10,317,000	$ 10,317,000
Total Construction	$ 61,902,000	$ 61,902,000
Indirect		
Owners Engineer	$ 500,000	$ 500,000
Bond Fees (2.5% of first $200,000,000)	$ 2,500,000	$ 2,500,000
Owners Cost (2%)*	$ 2,944,000	$ 2,944,000
Escalation	$ 5,091,000	$ 5,091,000
Sales Tax (5.5% equip/material)	$ 1,362,000	$ 1,362,000
Contingency (30%)	$ 21,882,000	$ 21,882,000
Total Project Cost	$ 96,181,000	$ 96,181,000
AFUDC	$ 7,984,000	$ 7,984,000
GRAND TOTAL COST ($2016)	$ 104,165,000	$ 104,165,000

Notes:
* Includes 2 weeks of sorbent injection testing.
The cost data in this table are subject to the critical assumptions recorded in S&L Letter No. NPPD-SL-0286.

Nebraska Public Power District
Gerald Gentleman Units 1&2

EXHIBIT 2A
Budgetary DSI O&M Cost Estimate (per Unit)
Hypothetical Scenario

Project No. 12681-003
April 28, 2011

Dry Sorbent Type		**Trona**
Design Removal Efficiency		**80% SO_2 Removal**
Particulate Collector		**Baghouse**
Input Data for System Analysis:		
Fuel		PRB
Gross Capacity	MW	745
Capacity Factor	%	80
Heat Input to Boiler at Full Load	MMBtu/hr	7,047
Fuel Heating Value	Btu/lb	8,124
Fuel Sulfur Content	lb/MMBtu	0.749
Fuel Ash Content	%	5.42
Ash Removal in Boiler	%	30.00
Dry Sorbent Injection Analysis:		
Dry Sorbent Requirement	lb/hr	38,000
Dry Sorbent Requirement	t/yr	166,440
Dry Sorbent Consumption	lb/hr @ CF	30,400
Dry Sorbent Consumption	t/yr @ CF	133,152
Waste Disposal Analysis:		
Flyash Production (Leaving the Boiler)	lb/hr	32,910
Sorbent Waste Rate	lb/hr	29,361
Total Waste for Disposal (Ash + Sorbent)	lb/hr	62,271
Total Waste for Disposal (Ash + Sorbent)	t/yr	272,748
Total Waste for Disposal (Ash + Sorbent)	t/yr @ CF	218,199
Auxiliaries Analysis:		
Increase in Auxiliary Power Consumption - Full Load	kW	3,800
Economic Parameters:		
Total number of Bags		16,474
Replacement Bag Cycle	years	6
Bag Replacement Cost	$/bag	172.00
Dry Sorbent Cost	$/t	145.00
Waste Disposal Cost	$/t	5.64
Revenue from Flyash Sale	$/t	1.35
Power: Energy Charge (Auxiliary Power)	$/MWh	45.65
Power: Capacity Charge	$/kW/year	46.00
Labor Rate	$/hr	40.60
Variable O&M Cost:		
Bag Replacement Cost	$/yr	$ 473,000
Dry Sorbent Cost	$/yr	$ 19,308,000
Waste Disposal Cost	$/yr	$ 1,231,000
Revenue from Flyash Sale	$/yr	$ -
Power: Energy Charge Cost (Auxiliary Power)	$/yr	$ 1,216,000
Power: Capacity Charge	$/yr	$ 174,800
SO2 Allowance Sale	$/yr	$ (40,000)
Total Estimated Variable O&M Cost	**$/yr**	**$ 22,362,800**
Fixed O&M Cost		
Additional Operating labor	no.	4.5
Additional Operating labor	$/yr	$ 382,000
Additional Maintenance Material	$/yr	$ 240,000
Additional Maintenance Labor	$/yr	$ 360,000
Additional Administrative labor	$/yr	$ -
Total Estimated Fixed O&M Cost	**$/yr**	**$ 982,000**

The cost data in this table are subject to the critical assumptions recorded in S&L Letter No. NPPD-SL-0286

Nebraska Public Power District
Gerald Gentleman Units 1&2

EXHIBIT 2B
Budgetary DSI Annualized O&M Cost Estimate (per Unit)
Hypothetical Scenario

Project No. 12681-003
April 28, 2011

Dry Sorbent Type			**Trona**
Design Removal Efficiency			**80% SO_2 Removal**
Particulate Collector			**Baghouse**
Levelized Variable O&M Cost:			
Bag Replacement Cost	$/yr	$	578,000
Dry Sorbent Cost	$/yr	$	23,556,000
Waste Disposal Cost	$/yr	$	1,502,000
Revenue from Flyash Sale	$/yr	$	-
Power: Energy Charge Cost (Auxiliary Power)	$/yr	$	1,484,000
Power: Capacity Charge	$/yr	$	214,000
SO2 Allowance Sale	$/yr	$	(49,000)
Total Estimated Levelized Variable O&M Cost	$/yr	$	27,285,000
Levelized Fixed O&M Cost:			
Additional Operating labor	$/yr	$	467,000
Additional Maintenance Material	$/yr	$	293,000
Additional Maintenance Labor	$/yr	$	440,000
Additional Administrative labor	$/yr	$	-
Total Estimated Levelized Fixed O&M Cost	$/yr	$	1,200,000
TOTAL ESTIMATED LEVELIZED O&M $2011	$/yr	$	28,485,000
TOTAL ESTIMATED LEVELIZED O&M TO 2016$	$/yr	$	32,229,000

The cost data in this table are subject to the critical assumptions recorded in S&L Letter No. NPPD-SL-0286.

Nebraska Public Power District
Gerald Gentleman Units 1&2

Project No. 12698-003
April 28, 2011

EXHIBIT 3
Annualized SO2 Cost of Compliance
Hypothetical Scenario

Description		Dry Sorbent Injection
Emission Rate (lb/MMBtu)		0.15
Emission Reduction (tpy)		39,815
Theoretical Normalized Stoichiometric Ratio		3.0
Emission Rate (lb/MMBtu)		0.15
Emission Reduction (tpy)		39,815
Capital Costs ($)	$	208,330,000
Annualized Capital Cost ($)	$	17,500,000
Annualized Operating Cost ($)	$	64,458,000
Annnualized Outage Cost ($)	$	-
Total Annualized Cost ($)	$	81,958,000
Normalized Cost ($/ton SO2 reduced)*	$	2,058

* Calculated based on the maximum actual 24-hour SO2 emissions realized over the 3-year baseline period (2001-2003) that was used in the 2008 BART Analysis.

The cost data in this table are subject to the critical assumptions recorded in S&L Letter No. NPPD-SL-0286.